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PROCEEDINGS OF 2nd MEDITERRANEAN SYMPOSIUM ON THE CONSERVATION OF CORALLIGENOUS AND OTHER CALCAREOUS BIO-CONCRETIONS

Portorož, Slovenia, 29-30 October 2014

ACTES DU 2ème SYMPOSIUM MÉDITERRANÉEN SUR LA CONSERVATION DU CORALLIGÈNE ET AUTRES BIO-CONCRÉTIONS

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UNEXPECTED ARTIFICIAL-REEF-LIKE EFFECT DUE TO A MEDITERRANEAN PIPELINE AND THE CONSERVATION OF TWO CIRCALITTORAL EMBLEMATIC SPECIES: *CENTROSTEPHANUS LONGISPINUS* AND *CYSTOSEIRA ZOSTEROIDES*

Abstract
The Gardanne alumina plant (western Provence, France) has since 1967 been discharging at sea bauxite residues through a pipeline with its outlet in the Cassidaigne Canyon (320 m deep), located in the Calanques National Park. Within the framework of the Barcelona Convention, discharging will end in December 2015. The question that arises is therefore: should these pipes be removed at the end of their exploitation? The two pipes were explored in May 2013 by means of a Remotely Operated Vehicle (ROV) equipped with a video camera. Outstanding species were identified and located. 344 individuals of the diadem sea urchin Centrostephanus longispinus were observed between 45 and 96 m depth along the pipelines. Such a high density has never been observed in the NW-Mediterranean. The brown alga Cystoseira zosteroides was common from the lower limit of the Posidonia oceanica seagrass meadow (30 m) down to 52 m depth, which represents one of the two most extensive populations within the Calanques National Park. The presence of significant populations of species of high heritage value (C. longispinus and C. zosteroides) in artificial habitats (subsea-pipelines), populations that may be more extensive than those located in natural habitats, raises questions with regard to the interest of these artificial habitats for conservation purposes, the justification for dismantling the unused pipes and the concepts of management and restoration of the marine environment.

Key-words: Artificial reef, *Centrostephanus longispinus*, Conservation, *Cystoseira zosteroides*, Pipeline.

Introduction
The alumina plant at Gardanne (western Provence, France) has since 1967 be discharging at sea solid, but diluted in freshwater, residues (0.2-1.4 Mt a^{-1}), of bauxite through a 25 cm diameter pipeline (Gardanne pipeline) with its outlet at 320 m depth in the submarine Canyon of Cassidaigne (Picard, 1978; Mioche, 2010). The path and the outlet of the pipeline are located within the recently established (April 2012) *Parc national des Calanques* (Calanques National Park). Another pipeline (La Barasse pipeline), now unused (since 1990), is located close to the Gardanne pipeline (Fig. 1).
In 1996, within the framework of the Barcelona Convention for the Protection of the Mediterranean Sea, the company Aluminium Pechiney (then owner of the site) made a commitment to reduce waste and to stop these discharges on December 31, 2015. Within this framework, the possible dismantling of the pipelines, after the end of their use, was studied by

Alteo, current operator of the plant. The question is: should we remove these pipelines? Or is it better to leave them in place in order to minimize the environmental impact?
Here, we report the results of the exploration of the 2 underwater pipelines (Gardanne and La Barasse), with special attention paid to the species of natural heritage value.

Materials and methods

The underwater stretch of the pipelines studied, between Port-Miou Cove and their outlets at the head of the Cassidaigne Canyon, at 320 m depth, is 7.5-km long (Fig. 1). With the exception of their initial landward part, the pipes cross soft bottom habitats. Pipelines were explored in May 2013 by means of a ROV (Remotely Operated Vehicle) equipped with a video camera, between 30 m (lower limit of the *Posidonia oceanica* (Linnaeus) Delile seagrass meadow) and 320 m depth.
The videos were analysed to identify and locate outstanding species, species with natural heritage value and/or species with a protection status established on the pipeline and in its close vicinity (~1 m). Species of this kind that were encountered included the diadem sea urchin *Centrostephanus longispinus* (Philippi, 1945) (Echinodermata, Metazoa) and the seaweed *Cystoseira zosteroides* C. Agardh (Phaeophyceae, Stramenopiles). Other species of *Cystoseira* were possibly present. Whenever an individual or group of individuals was observed, the coordinates were identified, on the basis of the navigation files established by the ROV. Between two geographical points recorded by the ROV, the intermediate positions of individuals were calculated (assuming that the speed of the ROV was regular). In addition, a scuba dive was performed (30-32 m depth) in order to collect specimens and check their identification.
The analysis of videos was made by means of the ZOODEX tool (ZOOlogical Data EXploitation system Zoological operating system; Goujard & Fourt, 2013). This tool enables transcription of the data in the form of logbook listing all the events corresponding to the observation of species, waste, substrates, etc. These events are pinpointed (longitude, latitude and depth) from the navigation files of the ROV.

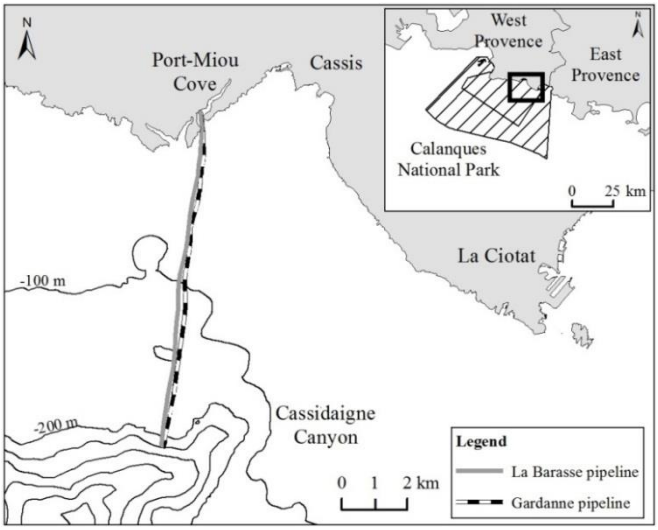

Fig. 1: Location of the study site and of the 2 pipelines. West Provence and East Provence correspond to the French administrative divisions 'Bouches-du-Rhône' and 'Var', respectively. Lines: depth contours.

Results

Along the path of the two pipelines, 344 individuals of *Centrostephanus longispinus* (Fig. 2) were counted, 176 and 168 on the La Barasse and Gardanne pipes, respectively. The depth ranged from 45 to 96 m and the distance from the shore from 730 to 3 950 m. However, most individuals (85%) were located between 60 and 75 m depth (Fig. 3). The mean density, in the stretch where sea urchins were present, was 0.6 individuals/10 m, and up to 4.6 individuals/10 m in densely occupied zones. The density peaks slightly differ between the two pipelines: 1 300-1 800 m from the shore and 65-75 m depth along the La Barasse pipe, versus 1 050-1 300 m from the shore and 60-65 m depth along the Gardanne pipe (Fig. 3).

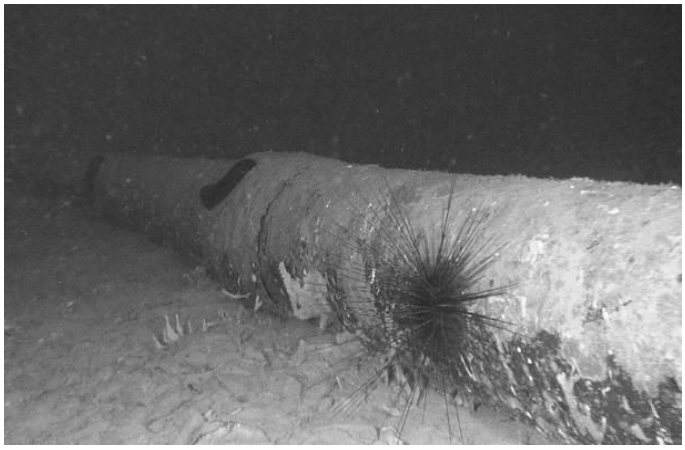

Fig. 2: A sea urchin *Centrostephanus longispinus* on the La Barasse pipeline, 68 m depth. Photo: ©ROV, COMEX.

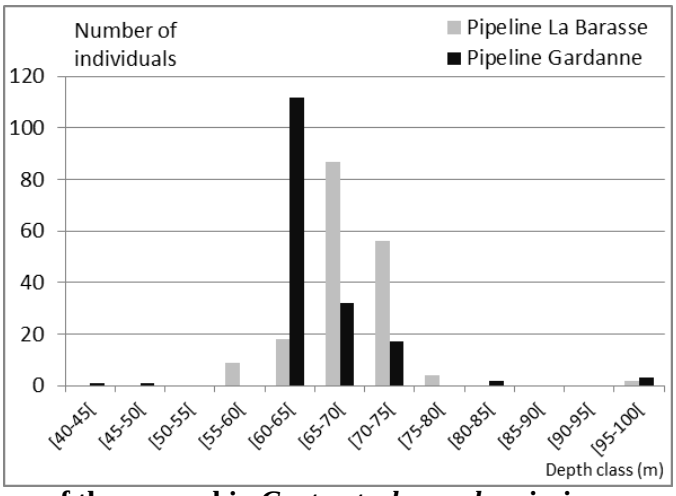

Fig. 3: Abundance of the sea urchin *Centrostephanus longispinus*, as a function of the depth, along the La Barasse and Gardanne pipelines, in May 2013.

On the 2 pipes, stands of the seaweed genus *Cystoseira* were observed, between the lower limit of the *P. oceanica* seagrass meadow (30 m) and 52 m depth (Fig. 4, 5). Between 30 and 32 m, scuba diving and collection of specimens enabled their identification as *C. zosteroides*. The presence of other species on the deepest parts of the pipes cannot be excluded, since these species cannot be distinguished from *C. zosteroides* on the basis of videos alone. Hereafter, '*Cystoseira zosteroides*' therefore means '*C. zosteroides* and (perhaps) other species of the genus *Cystoseira*'. *C. zosteroides* was more common (63%

of all records) on the Gardanne than on the La Barasse pipe; its depth range was 30 to 52 m and 32 to 40 m on the Gardanne and La Barasse pipes, respectively.

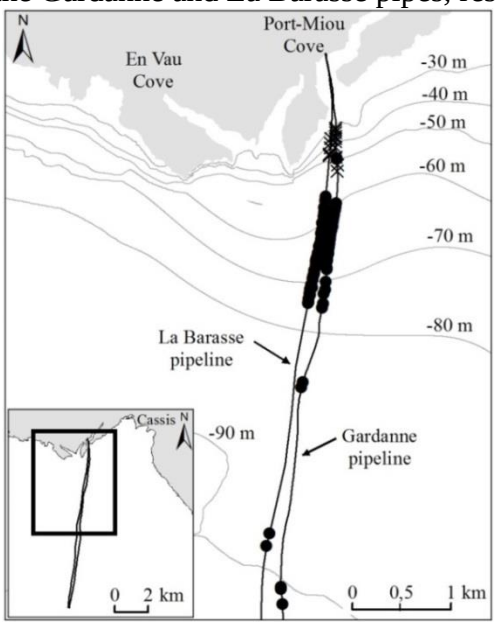

Fig. 4: Distribution of the sea urchin *Centrostephanus longispinus* (X) and the seaweed *Cystoseira zosteroides* (●) along the La Barasse and Gardanne pipelines. Each item (X or ●) means the presence of the species, either as an isolated individual or a more or less dense population.

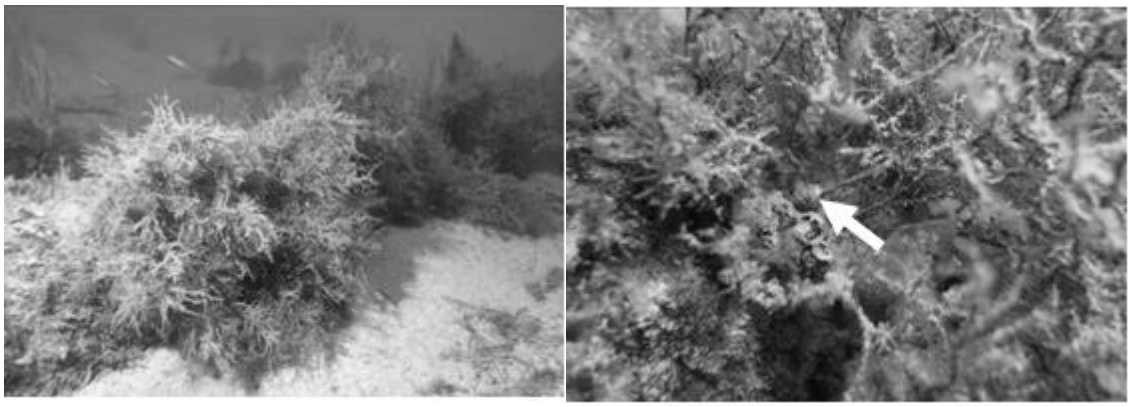

Fig. 5. Left: *Cystoseira zosteroides*, Gardanne pipeline, 32 m depth. Right: the arrow shows smooth 'tophules', storage organs playing the same role as the bulbs of terrestrial plants, a characteristic feature of the species. Photos: ©Patrick Bonhomme, GIS Posidonie.

Discussion and conclusions

The distribution range of the sea urchin *Centrostephanus longispinus* encompasses the Mediterranean Sea and the eastern Atlantic Ocean. It is a stenothermal species of warm water affinities, relatively rare in the north-western Mediterranean, but common in the western Atlantic (Francour, 1986, 1989, 1991; Le Loeuff, 1993; Templado & Moreno, 1996). In the Mediterranean, it dwells between 15 and 130 (up to 200) m depth, but is uncommon below 100 m (Tortonese, 1965; Francour, 1986; Agence des Aires Marines Protégées *et al.*, 2013). It grazes on benthic animals and primary producers, but can perhaps also utilize dissolved organic carbon (DOC) and particulate organic matter

(POM) carbon *via* the porous external surface of the spines (Régis, 1981; Paul *et al.,* 1983). Once settled at a location, *C. longispinus* seems to be relatively sedentary, but movement at a speed of 5-16 m h^{-1} has been observed (Paul *et al.,* 1983; Francour, 1986, 1991). *C. longispinus* is a protected species in France that is cited in several international conventions. Such a high density of *C. longispinus* has never before been recorded in the NW Mediterranean, or even perhaps at the scale of the entire Mediterranean Sea. Considering the proximity of the populations of the 2 pipes (~400 m) and the moving speed of the species, individuals thriving on the 2 pipes can be regarded as belonging to the same population.

Spawning aggregation is known in many sea urchin species, e.g. *Paracentrotus lividus* (Lamarck, 1816) (Boudouresque & Verlaque, 2013). The observed populations probably do not correspond to spawning aggregation, although the density probably enhances their reproductive efficiency. A possible difference in temperature at the surface of the pipe, due to the effluent, cannot be the driving parameter, as the 2 pipes, both active and non-used, are similarly colonized. Rather, colonization may result from the conjunction of a suitable hard substrate and the supply of feeding resource (DOC, POM) *via* currents, including the neighbouring Cassidaigne Canyon upwelling. In addition, the prohibition of trawling in the area, in order to avoid damaging the pipelines, may mimic a 'reserve effect' (Boudouresque *et al.,* 2005).

Cystoseira zosteroides is a perennial long-lived species, endemic to the Mediterranean Sea (Ballesteros *et al.,* 2009). Due to direct and indirect human impact, it has suffered dramatic loss and locally has become nearly extinct (Thibaut *et al.,* 2005). The species is regarded as a threatened species and is cited in several international conventions. The population of *C. zosteroides* established on the pipes constitutes one of the 2 largest stands known within the Calanques National Park, with the other located at Tiboulen de Maïre. Another stand is present at 63 m depth, at the mouth of Contrebandiers Cove, to the south of Riou Island (Bonhomme *et al.,* 2004; Rouanet *et al.,* 2012). Its thriving on the pipes may be related to the absence of trawling and the release from most macroherbivores, on an unusual hard substrate surrounded by vast areas of soft bottoms.

The presence of significant populations of species of high heritage value in artificial habitats (subsea-pipelines) does not challenge the value and protection status of these species. Rather, it draws attention to the possible interest of some man-made structures in the conservation of rare and threatened species. The study pipelines have obviously mimicked artificial reefs. This 'positive' result should be considered with caution: whatever the interest of some artificial habitats, as in the case of zoos, they cannot be seen as a substitute for species conservation in natural habitats. As regards the question of the dismantling and removing of the non-used pipes, this may seem justified from the standpoint of the 'naturalness' of the habitats of the Calanques National Park. However, in the context of the worrying decline of *C. zosteroides*, reduced to near extinction in extensive Mediterranean areas, including Marine Protected Areas, the alternative non-removal choice may also appear to present certain advantages.

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